

WHAT IS CLAIMED IS:

1 1. A packet flow control method comprising the steps  
2 of:

3 detecting congestion in a first node along a  
4 packet flow path between a source device and a  
5 destination device;

6 identifying a node in said path preceding said  
7 first node; and

8 transmitting to said preceding network node a  
9 traffic regulation signal used to initiate flow rate  
10 control on flows identified from information included in  
11 said traffic regulation signal.

1 2. The method of claim 1, wherein said information  
2 included in said traffic regulation signal includes a  
3 destination address.

1 3. The method of claim 2, wherein said step of  
2 identifying a node in said path includes the step of:  
3 transmitting a signal to said destination  
4 device requesting path information.

1 4. The method of claim 2, wherein the step of detecting  
2 congestion at a first node includes the steps of:  
3 monitoring to detect when said first node is  
4 saturated with packet traffic for a preselected period of  
5 time.

1     5.    The method of claim 4, wherein said traffic  
2    regulation signal further includes packet flow path  
3    information.

1     6.    The method of claim 5, further comprising the steps  
2    of:

3            operating said preceding network node to  
4    transmit an additional traffic regulation signal to an  
5    additional preceding node to cause the additional  
6    preceding node to initiate flow rate control on flows  
7    directed to a destination address identified in said  
8    additional traffic regulation signal.

1     7.    The method of claim 1, further comprising:

2            operating said preceding network node to  
3    perform a forced reduction in the flow rate of at least  
4    one packet flow in response to detecting traffic  
5    congestion.

1     8.    The method of claim 7, further comprising:

2            operating the first node to perform a forced  
3    reduction in the flow rate of at least one packet flow in  
4    response to detecting traffic congestion.

1     9.    The method of claim 8,

2            wherein the forced reduction in the flow rate  
3    performed in the first node is performed as a function of  
4    a base line flow rate for traffic flowing through the  
5    first node; and

6                wherein the forced reduction in the flow rate  
7 performed in the preceding network node is performed as a  
8 function of a base line flow rate for traffic flowing  
9 through the preceding network node.

1        10. A method of implementing flow control in a  
2 communications network including a first node, a second  
3 node and a destination node, the first node being located  
4 upstream of the second node on a communications path to  
5 said destination device, the method comprising the steps  
6 of:

7                operating the second node to detect when the  
8 second node is saturated with traffic for a period of  
9 time;

10              in response to detecting that said second node  
11 is saturated with traffic for said period of time,  
12 operating the second node to send a first traffic  
13 regulation signal to the first node to trigger said first  
14 node to perform traffic regulation of flow rates on flows  
15 of packets directed to said destination device.

1        11. The method of claim 10 wherein, in response to  
2 detecting that said second node is saturated with traffic  
3 for said period of time, said second node performs the  
4 step of:

5                initiating a path determination operation to  
6 determine at least a portion of a path of a flow causing  
7 congestion at said second node.

1 12. The method of claim 11, further comprising:

2 operating said second node to receive path  
3 information identifying said first node as part of said  
4 path of the flow causing congestion.

1 13. The method of claim 12, further comprising:

2 operating the second node to detect when the  
3 second node ceases to be saturated with traffic after  
4 being saturated for said period of time;

5 in response to the second node detecting that  
6 has ceased to be saturated with traffic, sending a second  
7 traffic regulation message to said first node to cause  
8 said first node to cease traffic regulation of flow rates  
9 on flows of packets directed to said destination device.

1 14. The method of claim 12, further comprising:

2 operating the first node, in response to said  
3 first traffic regulation message, to perform forced flow  
4 rate reduction operations on at least some flows directed  
5 to said destination node.

1 15. The method of claim 14, further comprising:

2 operating the first node to transmit a third  
3 traffic regulation message to a node located upstream of  
4 said first node in said path of the flow causing the  
5 congestion to trigger flow control operations in said  
6 node located upstream of said first node.

1 16. The method of claim 14, wherein operating the first  
2 node to perform forced flow rate reduction operations  
3 includes:

4 comparing packet flow rates of packet flows  
5 directed to said destination to at least one flow rate  
6 baseline for said first node; and

7 dropping packets from packet flows directed to  
8 said destination which have flow rates exceeding the flow  
9 rate base line to which the particular flow rate is  
10 compared.

1 17. The method of claim 16, further comprising, in said  
2 first node,

3 distinguishing, for traffic flow control  
4 purposes, between packet flows corresponding to protocol  
5 types which are responsive to congestion control signals  
6 and packet flows corresponding to protocol types which  
7 are not responsive to congestion control signals.

1 18. A communications system for communicating  
2 information as flows of packets, the system comprising:

3 a first network node including:

4 i. congestion control means for  
5 detecting congestion at said network node;

6 ii. traffic flow path determination  
7 means for determining the path of at least one  
8 packet flow causing congestion at said first  
9 network node; and

10                   iii. early traffic regulation  
11                   signaling means for transmitting a traffic  
12                   regulation signal to initiate traffic  
13                   regulation at an upstream network node; and  
14                   an upstream network node, the upstream network  
15 node being coupled to the first network node, the  
16 upstream network node including:

17                   i.    means for receiving traffic  
18                   regulation signals from said first network  
19                   node; and

20                   ii.  flow control means for performing  
21                   flow rate reduction operations on one or more  
22                   traffic flows identified from information  
23                   included in received traffic flow control  
24                   messages.

1       19. The communication system of claim 18, further  
2 comprising:

3                   a destination node coupled to said first network  
4 node for serving as the destination of at least some of  
5 the packet flows passing through the first network node,  
6 the destination node including:

7                   means for reconstructing packet flow paths from  
8 received information; and

9                   means for transmitting reconstructed packet  
10 flow path information to the first network node in  
11 response to a request for path information from said  
12 traffic flow path determination means.

1 20. The communication system of claim 19, wherein the  
2 traffic regulation signal generated by the early traffic  
3 regulation signaling means of the first network node  
4 includes a destination address corresponding to said  
5 destination node.

1 21. The communication system of claim 20,  
2 wherein the first network node includes traffic  
3 flow rate baselines generated from traffic flowing  
4 through the first network node over a period of time; and  
5 wherein the upstream network node includes  
6 traffic flow rate baselines generated from traffic  
7 flowing through the upstream network node over a period  
8 of time.

1 22. The communication system of claim 21,  
2 wherein the first network node further  
3 comprises flow control means for performing a flow  
4 control operation including the dropping of packets from  
5 at least one packet flow as a function of at least one of  
6 the first network node traffic flow rate baselines.

23. The communication system of claim 22, wherein the  
first network node further comprises:

a plurality of packet queues, one packet queue  
being used to store packets corresponding to a single or  
5 each group of flows to which are to be subject to  
different flow rate reduction operations are part of the  
processing by said flow control means.